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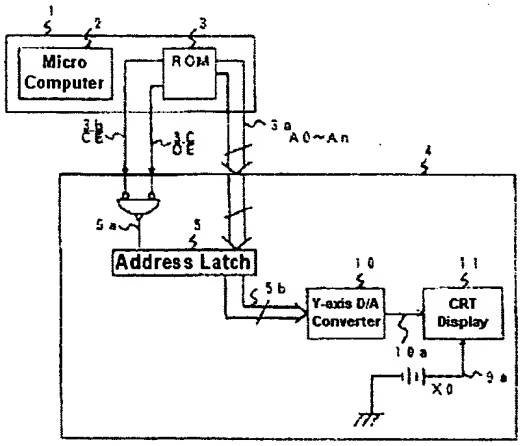
(54) **Invention Name** Real Time Program Measuring Device

(57) **Abstract**

**Purpose** To implement a visually easy to understand program measuring device that uses a flowchart display of real time program behavior.

**Composition** A program measuring device that displays the address currently being executed by a program, changing the display of at least one of the brightness, display width, or color values of that address, while it is being displayed along the vertical axis of a monitor screen, depending on the frequency that it is executed; does a tracking display, with a value separated along the X-axis, of only amount of variance in proportion of the values of the current address and the next address when the display moves from the vertical axis display position of the address presently being dealt with to the vertical axis position of the next address to be dealt with; and varies the display of the horizontal display position and the magnified display of part of the display address.



**Scope of Patent Application**

**Claim 1** This program measuring device is characterized in that it displays the address currently being executed by a program, changing the display of at least one of the brightness, display width, or color values of that address, while it is being displayed along the vertical axis of a monitor screen, depending on the frequency that it is executed.

**Claim 2** Concerning Claim 1, this program measuring device is characterized in that it does a tracking display, with a value separated along the X-axis, of only amount of variance in proportion of the values of the current address and the next address when the display moves from the vertical axis display position of the address presently being dealt with to the vertical axis position of the next address to be dealt with

**Claim 3** Concerning Claim 2, this program measuring device is characterized in that it varies the display of the horizontal display position and the magnified display of part of the display address.

**Invention Specification**

**0001**

**Field of Industrial Application** This invention is a product that acts as a measuring device that displays in real time the behavior condition of a microcomputer's or similar device's program.

**0002**

**Conventional Art** Measuring devices for analysis of the executing behavior of a microcomputer program have conventionally used a program tracer or logic analyzer. A program tracer is a product that writes to memory the trace of a program executed by a microcomputer, and afterwards displays readout of the contents of that memory trace of what stopped the execution of the program, and is useful in analyzing the execution behavior of a program. A purpose of a logic analyzer is, first of all, to analyze digital signals, but if it can observe signals from a microcomputer's address bus or data bus, it can also be used to analyze programs.

**0003**

**The Problem This Invention Proposes To Resolve** In the conventional art described above, there is a weakness in that a program's behavior cannot be observed in real time. The purpose of this invention is to resolve these weaknesses, display in real time a program's execution behavior condition, and to display it in a visually easy to understand way.

**0004**

**Procedures For Resolving The Problem** This invention is a product constructed as a real time program measuring device that displays the address currently being executed by a program, changing the display of at least one of the brightness, display width, or color values of that address, while it is being displayed along the vertical axis of a monitor screen, depending on the frequency that it is executed. Also it is a product constructed as a real time program measuring device that has a tracking display, with a value separated along the X-axis, of only amount of variance in proportion of the values of the current address and the next address when the display moves from the vertical axis display position of the address presently being dealt with to the vertical axis position of the next address to be dealt with. Furthermore, it is a product constructed as a real time program-

measuring device that varies the display of the horizontal display position and the magnified display of part of the display address.

**0005**

**Function** The address being executed by the current program can be measured in real time because its brightness, display width or color values change according to the frequency with which the program executes the address. Also, a flowchart of the program executing can be displayed in real time because when the address jumps in the + direction, the position, through which the locator is drawn on the display, moves to the right along the X-axis, and when the address jumps in the - direction, the position, through which the locator is drawn on the display, moves to the left along the X-axis. Furthermore, a flowchart of the whole program that is executing and a magnified flowchart of an address of one part can both be displayed.

**0006**

**Examples of Execution** The examples of execution of this invention are explained below by diagrams 1 through 8. Diagram 1 is a block diagram that shows the construction of the first example of execution of this invention. The device to be measured **(1)** is a product that consists of a microcomputer **(2)** and the ROM **(3)** which stores the program that controls it. By attaching test clips to the ROM **(3)**, address signal ($A_0$~$A_n$) **(3a)**, chip enable signal (CE) **(3b)**, and output enable signal (OE) **(3c)**, read out from the device to be measured **(1)**. **(4)** Is this invention's program measuring device, where address signal **(3a)** is latched by the address latch **(5)** and becomes latched address signal **(5b)**, which is converted to an analog value by the Y-axis D/A converter **(10)**, becomes the Y-axis signal **(10a)** for the CRT display **(11)**, and is input to the CRT display **(11)**. Here the CRT display **(11)** generates the X-axis signal **(9a)**, which has a fixed value $X_0$ that has been previously determined.

**0007** First, the behavior of Diagram 1 is explained through Diagram 2. When the program is executed, the address currently being executed can be known because the position of the address being dealt with lights up on the Y-axis of the display screen on the CRT display **(11)**. Also, because the brightness of display changes based on the frequency the program executes an address, when a program executes at high speed, the addresses currently being executed by the program can be measured in real time. Although in this example of execution the brightness is changed based off the frequency that the program executes an address, many other procedures can be considered, including, for example, changing the display width or changing the color.

**0008** Next, the second example of execution for this invention is described by the block diagram in Diagram 3 and the timing chart in Diagram 4. Up until the point where address signal **(3a)** is latched by address latch **(5)**, and becomes the latched address signal **(5b)**, this is the same as in Diagram 1. Latched address signal **(5b)** is switched again by the delayed phase address latch signal **(6a)** in address latch **(6)**, and becomes delayed phase latched address signal **(6b)**. When address signal **(6b)** is subtracted from address signal **(5b)** by the subtracter **(7)**, the variance address signal **(7a)**, as is shown in the timing chart of Diagram 4, is generated. When that variance address signal **(7a)** goes through delay circuit **(8)**, it becomes delayed address signal **(8a)**, and then becomes X-axis signal **(9a)** in the X-axis D/A converter **(9)**. Latched address signal **(6b)** also becomes Y-axis signal **(10a)** in the Y-axis D/A converter **(10)**, and is input to the CRT display **(11)**.

**0009** The condition of the display screen from the behavior of Diagrams 3 and 4 is explained in Diagram 5. The difference between the present address value and the last address value are compared, and so that a tracking line can be drawn on the display based off of the position of the value on the X-axis, when the address jumps in the + direction, because of a jump command or something similar, a tracking line is drawn along the X-axis towards the right, when the address jumps in the – direction, the tracking line is drawn towards the left, if the variance in addresses jumped is large, the line is also large, because this tracking line is drawn based off the movement of the value along the X-axis a flowchart can be displayed of the execution state of the program in real time.

**0010** The third example of execution of this invention is explained by the block diagram in Diagram 6, and the detailed block diagram of the display range magnification procedure **(12)** in Diagram 7. With any of the ranges decided by the display range setting coefficient **(12d)** (shown by the codes $A_{ST1}$, $A_{WD1}$, $A_{ST2}$, $A_{WD2}$, $A_{ST3}$, $A_{WD3}$) by address signal **(6b)** (shown as code $A_{IN}$) which is input to the display range magnification procedure, the procedure changes 3 types of output values (the X-axis jump tracking line magnification coefficient K: **(12a)**, the movement amount, $X_{PULSE}$: **(12b)**, which shows the position of the X-axis direction displaying the signal that magnified the Y-axis, and address signal that magnified the Y-axis $D_{OUT}$: **(2c)**). This is processed in the following manner:

IF, $A_{ST1} \leq A_{IN} < A_{ST1}+A_{WD1}$, THEN
$D_{OUT} = (A_{IN}-A_{ST1})*K$
$K = 10000H/A_{WD1}$
$X_{PULSE} = X_1$
IF, $A_{ST2} \leq A_{IN} < A_{ST2}+A_{WD2}$, THEN
$D_{OUT} = (A_{IN}-A_{ST2})*K$
$K = 10000H/A_{WD2}$
$X_{PULSE} = X_2$
IF, $A_{ST3} \leq A_{IN} < A_{ST3}+A_{WD3}$, THEN
$D_{OUT} = (A_{IN}-A_{ST3})*K$
$K = 10000H/A_{WD3}$
$X_{PULSE} = X_3$

**0011** The state of the display screen, due to the behaviors of Diagrams 6 and 7, are explained below by Diagram 8. When address signal ($A_{IN}$) **(6b)** includes Range 1 (the range 0000xH to FFFFxH, but not including 5000xH to 5FFFxH of Range 2), the X-direction position is displayed as $X_1$'s position. When address signal ($A_{IN}$) **(6b)** includes Range 2 (the range 5000xH to 5FFFxH, but not including 5C00xH to 5CFFxH of Range 3), the X-direction position is displayed as $X_2$'s position. When address signal ($A_{IN}$) **(6b)** includes Range 3 (the range 5C00xH to 5CFFxH), the X-direction position is displayed as $X_3$'s position. Through this, flowcharts from the entire program, down to the smallest detail can be observed at the same time.

**0012** Insert Text Here.

**Advantageous Effect of the Invention** With this invention, because a program's behavior is displayed as a flowchart in real time, the program is visually easy to understand. Because of this, the efficiency of program analysis increases.

**Simple Explanation of Diagrams**

**Diagram 1** A block diagram showing the first example of execution of this invention.

**Diagram 2** An example diagram of a CRT display screen showing the behavior of Diagram 1

**Diagram 3** A block diagram showing the second example of execution of this invention.

**Diagram 4** Time chart showing the behavior of Diagram 3

**Diagram 5** An example diagram of a CRT display screen showing the behavior of Diagram 3

**Diagram 6** A block diagram showing the third example of execution of this invention.

**Diagram 7** An explanation chart of the display range magnification procedure (12) from Diagram 6

**Diagram 8** An example diagram of a CRT display screen showing the behavior of Diagram 6

**Explanation of Symbols**

**1** Device to be measured
**2** Microcomputer
**3** ROM (Read Only Memory)
**4** Program measuring device
**5, 6** Address latches
**7** Subtracter
**8** Delay circuit
**9** X-axis D/A converter (Digital/Analog)
**10** Y-axis D/A converter
**11** CRT display
**12** Display range magnification procedure
**13** Multiplier
**14** Adder
**15** Display range setting procedure

Diagram 1

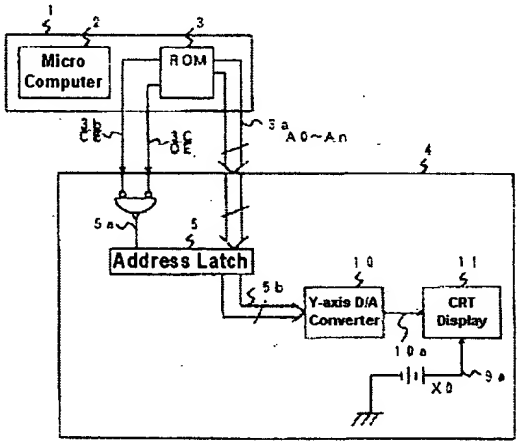


Diagram 2

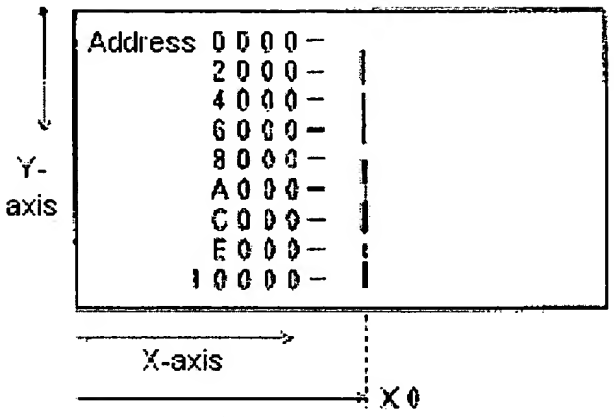



Diagram 3

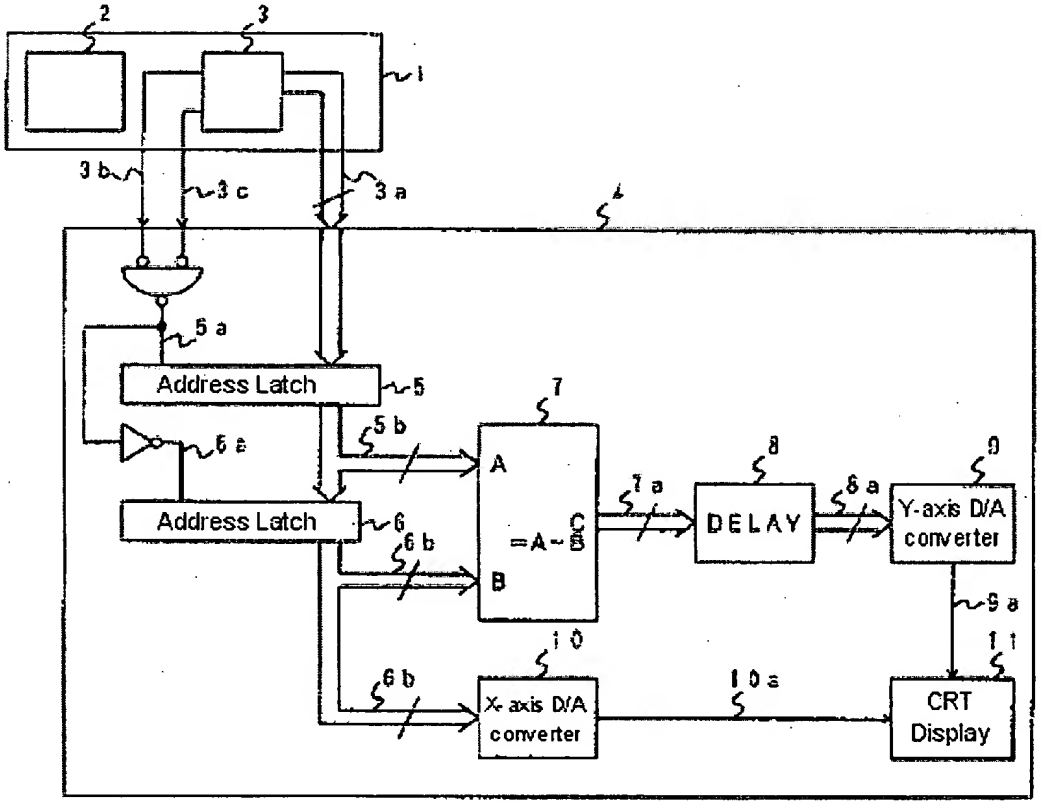


Diagram 4

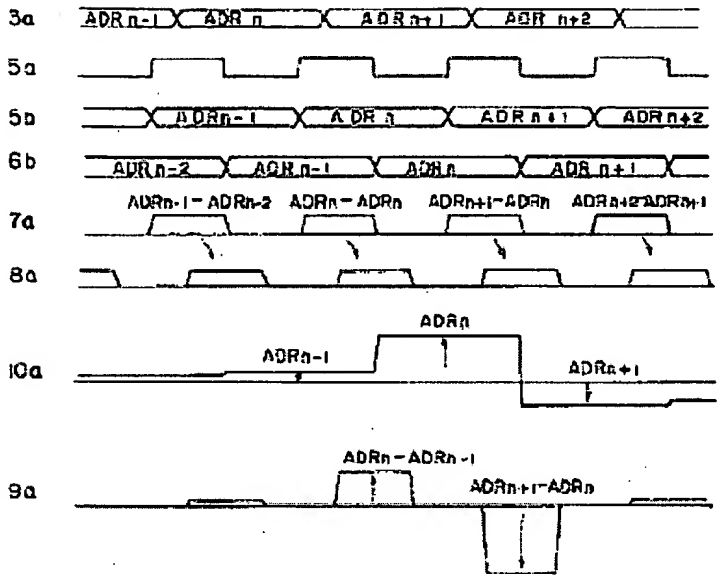



Diagram 5

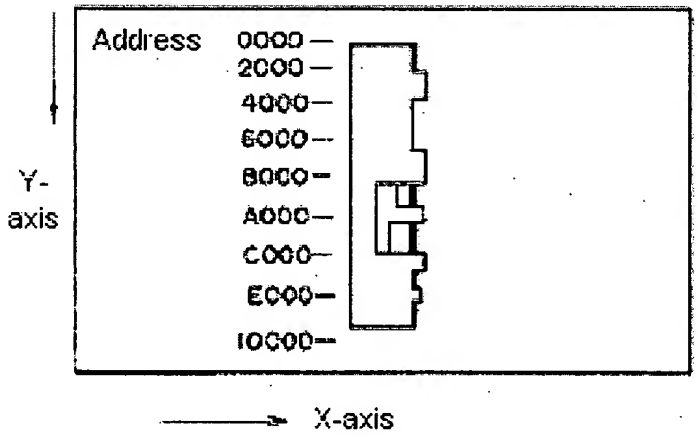


Diagram 6

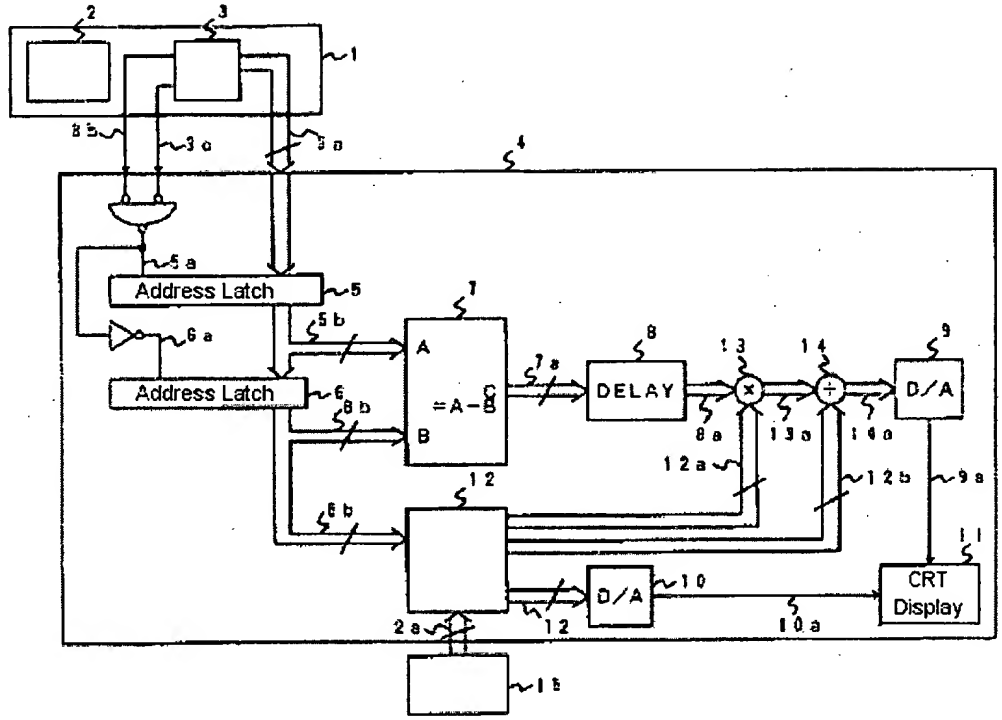
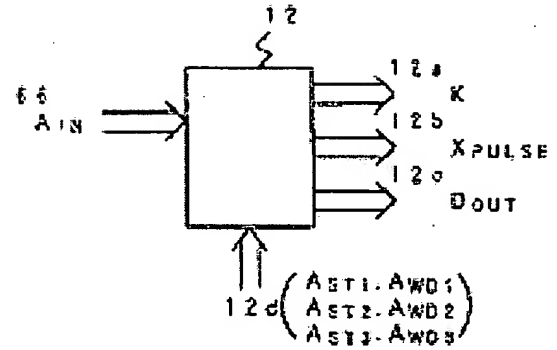


Diagram 7


12
66
AIN
12a
K
12b
XPULSE
12c
DOUT
12d
(AST1, AWD1
AST2, AWD2
AST3, AWD3)

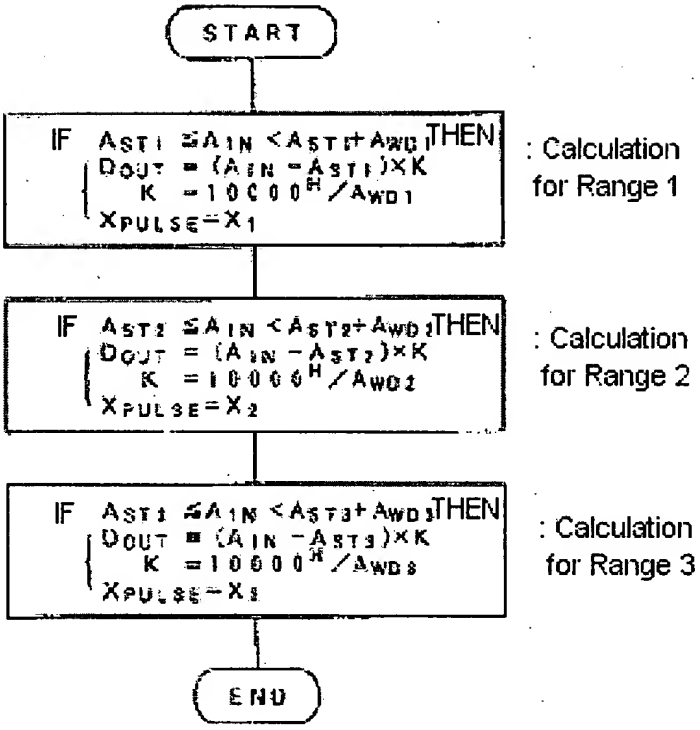
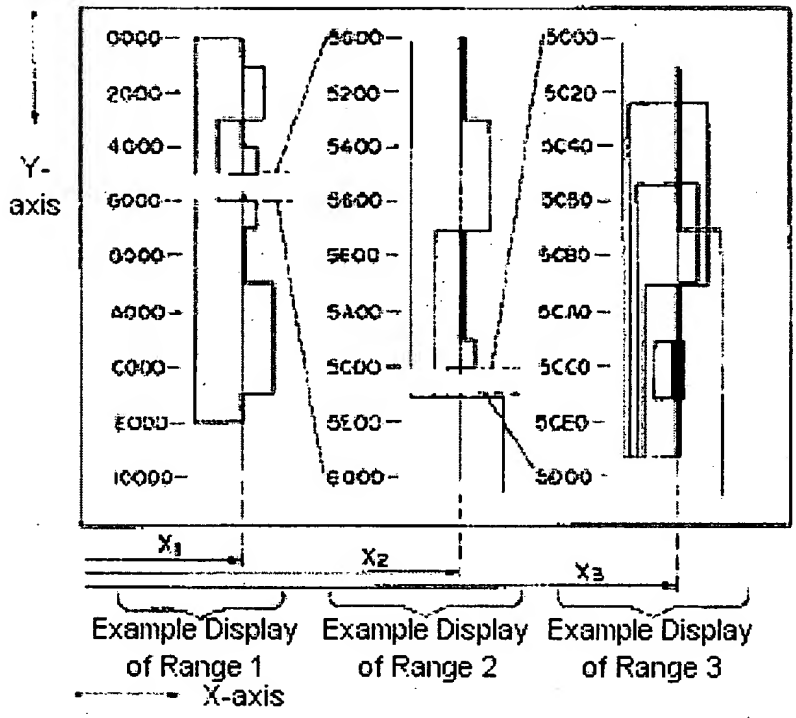

START
IF AST1 ≦AIN <AST1+AWD1 THEN
DOUT = (AIN −AST1)×K
K =10000H/AWD1
XPULSE=X1
: Calculation for Range 1
IF AST2 ≦AIN <AST2+AWD2 THEN
DOUT = (AIN −AST2)×K
K =10000H/AWD2
XPULSE=X2
: Calculation for Range 2
IF AST3 ≦AIN <AST3+AWD3 THEN
DOUT = (AIN −AST3)×K
K =10000H/AWD3
XPULSE=X3
: Calculation for Range 3
END

Diagram 8


Y-axis
0000
2000
4000
6000
8000
A000
C000
E000
10000
5000
5200
5400
5600
5800
5A00
5C00
5E00
6000
5000
5C20
5C40
5C60
5C80
5CA0
5CC0
5CE0
5D00
X1
X2
X3
Example Display of Range 1
Example Display of Range 2
Example Display of Range 3
X-axis